REMARKS

Claims 8, 12, 15, 18 and 21 are pending in this application. By this Amendment, claim 8 is amended and claims 9-11, 13, 14, 16, 17, 19, 20, 22 and 23 are canceled. Support for the amendments to claim 8 may be found, for example, in the claims as originally filed and the specification at: page 10, lines 1-16; page 12, line 22 - page 13, line 4; and page 14, line 1 - page 16, line 5. No new matter is added.

Applicants appreciate the courtesies shown to Applicants' representative by Examiner Rao in the May 1, 2009 personal interview. Applicants' separate record of the substance of the interview is incorporated into the following remarks.

In view of the foregoing amendments and following remarks, reconsideration and allowance of the application are respectfully requested.

I. Rejections Under 35 U.S.C. §103

A. Ono and Sakurada

The Office Action rejects claims 8-17 and 21-23 under 35 U.S.C. §103(a) over U.S. Patent Application Publication No. 2002/0017234 to Ono et al. ("Ono") in view of U.S. Patent Application Publication No. 2003/0116082 to Sakurada ("Sakurada"). By this Amendment, claims 9-11, 13, 14, 16, 17, 22 and 23 are canceled, thus the rejection is moot as to those claims. As to the remaining claims, Applicants respectfully traverse the rejection.

By this Amendment, claim 8 recites, *inter alia*, "A method for producing a single crystal by pulling a single crystal from a raw material melt in a chamber in accordance with Czochralski method ... wherein the pulling of the single crystal is performed with being controlled by arranging at least a cooling cylinder to be forced cooled with a cooling medium and an auxiliary member for cooling in the chamber so that an average of cooling rate in passing through a temperature region of the melt point of the single crystal to 950 °C is in the range of 0.96 °C/min or more and so that an average of cooling rate in passing through a

temperature region of 1150 °C to 1080 °C is in the range of 0.88 °C/min or more and so that an average of cooling rate in passing through a temperature region of 1050 °C to 950 °C is in the range of 0.71 °C/min or more, and thereby preventing aggregation of point defects, and wherein a growth rate margin for pulling the single crystal having a defect-free region (an upper limit of the growth rate – a lower limit of the growth rate) is in the range of 7% or more of a growth rate average of the single crystal ((the upper limit of the growth rate + the lower limit of the growth rate) ÷ 2)." Applicants respectfully assert that Ono and Sakaruda, individually or in combination, would not have rendered obvious at least the above features of claim 8.

The claimed method provides for pulling a single crystal having a defect-free region (that is in an N region) by controlling a V/G value. The pulling of the single crystal is controlled by arranging at least a cooling cylinder to be forced cooled with a cooling medium and an auxiliary member for cooling in the chamber so that averages of the cooling rate in passing through each of: a temperature region of the melt point of the single crystal to 950°C; a temperature region of 1150°C to 1080°C; and a temperature region of 1050°C to 950°C are respectively in the range of: 0.96°C/min or more; 0.88°C/min or more; and 0.71°C/min or more. By controlling the cooling rates as claimed, one can prevent the aggregation of point defects and allow the growth rate margin for pulling the single crystal having an N region to be in the range of 7% or more of a growth rate average of the single crystal. See specification, page 10, lines 1-16 and page 15, line 6 - page 16, line 5.

Conventionally, a method for controlling an average of the cooling rate in passing through a temperature region of 1080°C to 1150°C has been 1°C/min or more, for example, to enlarge the growth rate margin of the defect-free crystal. However, by using the claimed cooling cylinder and auxiliary member for cooling, the pulling can be controlled so that the respective temperature regions can be rapidly cooled at the claimed cooling rates. See

specification, page 17, line 2 - page 18, line 2. Thus, the claimed method allows the production of a single crystal having an N region to be easily performed and results in a higher yield of single crystals having an N region. See specification, page 9, lines 4-20.

Ono is merely directed to controlling cooling rates while pulling up a single crystal so that oxide precipitate nuclei in a wafer can be stably rendered and grown. See Ono, paragraphs [0031]-[0033]. Ono does not require any additional heat treatment steps following pulling up a silicon single crystal and prior to an epitaxial step. Thereby, the oxide precipitate nuclei in the wafer will not diminish in the epitaxial step and form oxide precipitates, thus epitaxial wafers capable of exhibiting high IG capability are provided. See Ono paragraph [0014] and Example 2. This differs from the claimed method.

The Office Action, on page 3, asserts that Ono discloses the fabrication of single crystals via the Czochralski (Cz) method, whereby single crystal products may allegedly be produced that have a substantially defect-free region in the Denuded Zone (DZ), which the Office Action asserts is generally understood to be in existence outside the OSF region.

However, Ono merely discloses a process of device manufacture wherein oxygen existing near the wafer surface is diffused to the outside by a high-temperature heat treatment. Thereby, a surface-layer region, where the device is to be formed, is formed from the Denuded Zone layer, which is free of crystal defects. Put differently, the portion of Ono relied upon by the Office Action is directed to a process of manufacturing wafers and, thus, unlike claim 8, it has no relation to controlling a V/G value or pulling a single crystal having an N region in the process of producing a single crystal ingot in accordance with the Cz method. Also, Ono is directed to epitaxial wafers, and it is merely by epitaxial growth that a crystal-defect-free region is formed on the surface. The epitaxial growth also has no relation to pulling a single crystal having an N region or controlling a V/G value in pulling a single crystal ingot, as recited in claim 8. Therefore, Applicants respectfully assert that it would not

have been obvious to one of ordinary skill in the art to have modified the process disclosed in Ono, which is directed to forming wafers and epitaxial growth, to provide the claimed method of pulling a single crystal having an N region or controlling a V/G value, as recited in claim 8.

The Office Action further asserts that Ono discloses a series of cooling rate steps that fall within the ranges as claimed. See Office Action, page 3. However, Ono merely discloses, "[t]he second single crystal is a silicon single crystal produced by the Czochralski method by selecting a cooling rate of not less than 7.3° C./min in the temperature range of 1200-1050° C. in the step of pulling up and a cooling rate of not more than 3.5° C./min in the temperature range of 1000-700° C. The method of manufacturing epitaxial wafers according to the present invention is characterized in that an epitaxial layer is grown on the surface of silicon wafers sliced from that single crystal." Ono, paragraph [0031]. Applicants respectfully assert that the above disclosure of Ono fails to disclose the temperature ranges and corresponding cooling rates as recited in claim 8.

As stated above, Ono merely discloses pulling up during the first cooling step, wherein the temperature range is from 1200-1050°C and the cooling rate is not less than 7.3°C/min. Ono then discloses that a slow cooling of not more than 3.5°C/min takes place in the temperature range of 1000-700°C in order to form an oxide precipitate nuclei. See Ono, paragraph [0032]. However, Ono fails to disclose, or provide any reason or rationale for, controlling the average cooling rate passing through a temperature region of the melt point of the single crystal to 950°C that is in the range of 0.96°C/min or more. Similarly, Ono fails to disclose, or provide any reason or rationale for, controlling the pulling of the single crystal so that an average cooling rate in passing through a temperature region of 1050°C to 950°C is in the range of 0.71°C/min or more.

As stated above, Ono fails to disclose, and would have rendered obvious, all of the average cooling rates passing through the three claimed temperature regions. At best, Ono

merely discloses cooling rates within a portion of the temperature regions recited in claim 8. Thus, there are claimed temperature regions with corresponding cooling rates that are not overlapped by Ono. Therefore, Ono fails to disclose, or provide any reason or rationale to control, the average cooling rates passing through all three of the claimed temperature regions—especially the temperature region from the melt point of the single crystal to 950°C and the region from 1050°C to 950°C—as recited in claim 8. Accordingly, Ono fails to provide any reason or rationale for one of ordinary skill in the art to have expected that the process disclosed in Ono would yield a product with the same benefits and properties as the method recited in claim 8.

Further, Ono is directed to controlling cooling rates to retain the stability of oxide precipitation. See Ono, paragraphs [0014] and [0032]. In contrast, controlling the average cooling rates as claimed, in all three of the claimed temperature regions, allows aggregation of point defects to be prevented. Such an effect is not realized by the process of Ono. Furthermore, unlike the claimed method, Ono neither discloses, nor provides any reason or rationale for, making a growth rate margin for pulling the single crystal having an N region to be within the range of 7% or more of a growth rate average of the single crystal. By controlling the average cooling rate in passing through the three claimed temperature regions, aggregation of point defects can be prevented and the V/G value that is within the defect-free (N) region can be considerably enlarged. Ono fails to provide these effects.

The Office Action, on page 4, acknowledges that Ono fails to disclose interstitial-type and vacancy-type defect non-existence via controlling the V/G value as indicated by growth rate (V) and temperature gradient (G) near a growth interface, the specified diameter growth, and whether a magnetic field is employed. Thus, the Office Action applies the disclosure of Sakurada to allegedly address the discrepancies of Ono.

However, Sakurada merely describes a method in which a crystal is grown in a

defect-free region, which is an N region, on the outside of OSF in which a defect region, as detected by copper deposition, does not exist. Sakurada does not disclose or provide any reason or rationale for one of ordinary skill in the art to have controlled the average cooling rate passing through the three temperature regions as claimed, or that pulling up of a single crystal within the three claimed temperature regions at the three claimed cooling rates would result in an enlarged V/G value that falls within a defect-free zone. Further, Sakurada does not disclose or provide any reason or rationale for one of ordinary skill in the art to have been aware that controlling the average cooling rates within the three claimed temperature regions could or would prevent aggregation of point defects. Accordingly, Applicants respectfully assert that Sakurada does not address the above discrepancies of Ono as to claim 8. Therefore, Ono and Sakurada, individually or in combination, would not have rendered obvious each and every feature of claim 8.

Claim 8 would not have been rendered obvious by Ono and Sakurada, individually or in combination. Claims 12, 15 and 21 depend from claim 8 and, thus, also would not have been rendered obvious by Ono and Sakurada, individually or in combination. Accordingly, reconsideration and withdrawal of the rejection are respectfully requested.

B. Ono, Sakurada and Iino

The Office Action rejects claims 18-20 under 35 U.S.C. §103(a) over Ono in view of Sakurada and further in view of U.S. Patent No. 5,980,630 to Iino et al. ("Iino"). By this Amendment, claims 19 and 20 are canceled, thus the rejection is moot as to those claims. As to claim 18, Applicants respectfully traverse the rejection.

For at least the reasons stated above, Ono and Sakurada would not have rendered obvious each and every feature of claim 8. The Office Action merely applies Iino as disclosing employing a magnetic field in the growth of single crystalline ingot materials. Therefore, Iino is not applied to address the above discrepancies of Ono and Sakurada. Thus,

Ono, Sakurada and Iino, individually or in combination, would not have rendered obvious each and every feature of claim 8.

Claim 8 would not have been rendered obvious by Ono, Sakurada and Iino, individually or in combination. Claim 18 depends from claim 8 and, thus, also would not have been rendered obvious by Ono, Sakurada and Iino, individually or in combination. Accordingly, reconsideration and withdrawal of the rejection are respectfully requested.

II. Conclusion

In view of the foregoing, it is respectfully submitted that this application is in condition for allowance. Favorable reconsideration and prompt allowance of the application are earnestly solicited.

Should the Examiner believe that anything further would be desirable in order to place this application in even better condition for allowance, the Examiner is invited to contact the undersigned at the telephone number set forth below.

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WPB:NAB

Attachments:
Request for Continued Examination
Petition for Extension of Time

Date: May 7, 2009

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